a2 cont'd

~~9~~ 8. (Amended) The method of claim ~~8~~ 7, wherein the diluent gas comprises an inert gas.

Sub B7

~~12~~ 9. (New) The method of claim 1, wherein the crystal nucleus of perovskite structure is formed prior to forming the ferroelectric film.

a3 Sub C1

~~13~~ 10. (New) The method of claim 1, further comprising:

providing a vaporizer;

transferring a solution and organic metal sources of lead, zirconium, and titanium to the vaporizer;

dissolving the organic metal sources of lead, zirconium, and titanium in the solution, thereby generating the metal source gases; and

vaporizing the solution.

REMARKS

By this Amendment, Applicants have changed the title, cancelled claim 7 without prejudice or disclaimer, and added new claims 12 and 13. No new matter has been added. Accordingly, claims 1-6, and 8-13 are pending in the application.

In the Office action of June 20, 2001, the Examiner asserted a restriction requirement under 35 U.S.C. § 121; acknowledged Applicants' provisional election with traverse to prosecute Group I, claims 1-9; acknowledged receipt of the priority document, Japanese Patent Application No. 066552/1999; required a new title; requested Applicants' cooperation in correcting any errors in the specification of which Applicants may become aware; rejected claims 1-9 under 35 U.S.C. § 112, second

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paragraph; and rejected claims 1-9 under 35 U.S.C. § 103(a) as being unpatentable over Suzuki et al. (U.S. Patent Number 6,190,728), Roeder et al. (U.S. Patent Number 5,876,503), or Desu et al. (U.S. Patent Number 5,817,170).

With respect to the restriction requirement, Applicants affirm the election to prosecute claims 1-9, and reserve the right to prosecute non-elected claims 10 and 11 in a divisional application.

With respect to the Examiner's requirement for a new title, Applicants have changed the title as suggested by the Examiner.

With respect to the Examiner's request for cooperation with correcting any errors that the Applicants have found in the specification, Applicants have not found any errors in the specification.

With respect to the rejection of claims 1-9 under 35 U.S.C. § 112, second paragraph, Applicants have amended the claims to correct grammatical and idiomatic errors in order to conform with U.S. practice. No new matter has been added. Additionally, claim 7 has been cancelled without prejudice or disclaimer. The changes made to the claims by this Amendment are not meant to limit the scope of the coverage of the claims, and the language of the Amendment should not be so interpreted.

With respect to the rejection of claim 1 due to the use of the term "thin film," Applicants respectfully regard this term as definite under the statute. The Examiner asserts that the "term 'thin' is not defined by the claim ... and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention." According to the M.P.E.P., the "definiteness of the claim language must be analyzed, not in a vacuum, but in light of: (A) [t]he content of the particular application disclosure; (B) [t]he

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teachings of the prior art; and (C) [t]he claim interpretation that would be given by one possessing the ordinary level of skill in the pertinent art at the time the invention was made." § 2173.02.

The term "thin film" is often used in the art of semiconductor manufacturing with respect to various layers of material in a given device. For example, in the Suzuki et al. reference cited by the Examiner, the term "thin film" is used in the preamble of the claims. Therefore, under M.P.E.P. § 2173.02, Applicants regard the use of the term "thin film" as having a meaning that would be understood by those possessing ordinary skill in the art. As a result, Applicants consider the term "thin film" to be definite under 35 U.S.C. § 112, second paragraph, and Applicants respectfully request reconsideration and withdrawal of this rejection.

In the Office Action, the Examiner rejected claims 1-9 under 35 U.S.C. § 103(a) as being unpatentable over Suzuki et al., Roeder et al., or Desu et al.

Applicants respectfully traverse each of these rejections under 35 U.S.C. § 103(a) because the cited references fail to teach or suggest every element of the invention as recited in amended independent claim 1. In order to establish a *prima facie* case of obviousness, the "reference (or references when combined) must teach or suggest all the claim limitations." M.P.E.P. § 2143.

Applicants' invention as recited in amended claim 1 is directed to a method of forming a thin film on a substrate in a reactor including a side having a shower head with a plurality of nozzles and a separate discharge nozzle. The method includes forming a crystal nucleus of perovskite structure on the substrate, with the crystal nucleus of perovskite structure including an oxide formed of lead and titanium. The

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method further includes positioning the substrate in the reactor, heating the substrate to a predetermined temperature, supplying the reactor with organic metal source gases composed of lead, zirconium, and titanium via the plurality of nozzles, with the organic metal source gases being diluted with a diluent gas. The method further includes supplying the reactor with an oxide gas via the separate discharge nozzle, forming a ferroelectric film on the substrate, where the ferroelectric film includes a perovskite crystal structure formed by an oxide composed of lead, zirconium, and titanium. The method occurs at a total pressure in the reactor of at least about 0.1 Torr.

In contrast, the Suzuki et al. reference discloses

> a process for forming a functional ceramic thin film having a crystal of a composite oxide consisting of two or more metal elements and oxygen, which comprises steps of alternately stacking seeding layers having the same crystalline structure as the composite oxide and formable at a temperature lower than the crystallization temperature of the composite oxide, and layers containing a larger amount of a specified metal element than said seeding layers, and then annealing the resultant layers to form an integral body.

Suzuki et al., col. 1, lines 66 and 67; col. 2, lines 1-8.

With respect to claim 1 as amended, the Suzuki et al. reference fails to disclose or suggest at least a method of forming a thin film on a substrate in a reactor including a side having a shower head with a plurality of nozzles and a separate discharge nozzle, wherein the method includes forming a crystal nucleus of perovskite structure on the

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substrate, supplying the reactor with organic metal source gases including lead, zirconium, and titanium via the plurality of nozzles, with the organic metal source gases being diluted with a diluent gas, and supplying the reactor with an oxide gas via the separate discharge nozzle, occurring at a total pressure in the reactor of at least about 0.1 Torr.

In contrast with Applicants' invention as recited in claim 1, the Roeder et al. reference discloses

> a process for forming a multiple component material layer on a substrate by vapor deposition, from multiple liquid phase precursors for components of the material layer to be formed [including] flowing at least one but less than all of the multiple liquid phase precursors to a first vaporization zone, and vaporizing [the] precursors ... to form a first precursor vapor; and flowing at least one other of the multiple phase precursors to a second vaporization zone, and vaporizing [the] other flowed precursors ... to form a second precursor vapor; and ... depositing the multiple component material layer on the substrate from the first and second precursor layer.

Roeder et al., col. 5, lines 41-59.

With respect to claim 1 as amended, the Roeder et al. reference fails to disclose at least a method of forming a thin film on a substrate in a reactor including a side having a shower head with a plurality of nozzles and a separate discharge nozzle,

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wherein the method includes forming a crystal nucleus of perovskite structure on the substrate, heating the substrate to a predetermined temperature, supplying the reactor with organic metal source gases including lead, zirconium, and titanium via the plurality of nozzles, with the organic metal source gases being diluted with a diluent gas, and supplying the reactor with an oxide gas via the separate discharge nozzle, occurring at a total pressure in the reactor of at least about 0.1 Torr.

The Desu et al. reference discloses

> [a] seeding layer (20) ... deposited into a substrate (10), [a] ferroelectric film (30) ... deposited onto the seeding layer, and a capping layer (40) ... deposited on top of the ferroelectric film. The substrate (10) ... can be electrode-coated silicon wafers or any suitable substrates. The seeding layer is lead titanate, the ferroelectric film is lead zirconate titanate, and the capping layer is lead oxide....

Desu et al., col. 4, lines 49-58.

With respect to claim 1 as amended, the Desu et al. reference fails to disclose at least a method of forming a thin film on a substrate in a reactor including a side having a shower head with a plurality of nozzles and a separate discharge nozzle, wherein the method includes forming a crystal nucleus of perovskite structure on the substrate, heating the substrate to a predetermined temperature, supplying the reactor with organic metal source gases including lead, zirconium, and titanium via the plurality of nozzles, with the organic metal source gases being diluted with a diluent gas, and

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supplying the reactor with an oxide gas via the separate discharge nozzle, occurring at a total pressure in the reactor of at least about 0.1 Torr

Therefore, for at least these reasons, the Suzuki et al., Roeder et al., and Desu et al. references fail to disclose every feature of independent claim 1.

In the Office action, the Examiner admits that "the references fail to teach a crystal nucleus of perovskite structure on an oxide made of lead and titanium on a substrate." However, the Examiner asserts that "[i]t would have been obvious to utilize crystals of these materials with the expectation of obtaining similar results in the absence of a showing of unexpected results. Additionally, with respect to the rejection of claims 2-9 under 35 U.S.C. § 103(a), the Examiner asserts that "[i]t would have been obvious to one having ordinary skill in the art to have determined the optimum values of the relevant process parameters such as flow rates and carrier gases through routine experimentation in the absence of a showing of criticality."

Applicants' invention as recited in amended claim 1 provides benefits not disclosed or suggested by the references cited by the Examiner. For example, by maintaining a pressure of at least about 0.1 Torr, it is possible to supply each gas to the reactor in a range between intermediate flow and viscous flow. This, combined with supplying the gases through the plurality of nozzles, results in the formation of a uniform thin film layer on the substrate. Furthermore, by diluting the metal source gases with a diluent gas, the total pressure of at least 0.1 Torr is achieved without increasing the pressure of the metal source gases. This prevents the metal source gases from reacting with the oxide gas until after they are supplied to the substrate, resulting in superior crystal formation on the substrate. Additionally, the metal source gases and

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the oxide gases are supplied to the reactor through separate nozzles. This allows the metal source gases and the oxide gas to be supplied to the substrate in a more stable form, resulting in a more uniform thin film formation. Therefore, the combination of elements of Applicants' invention recited in amended claim 1 results in benefits neither disclosed nor suggested by the cited references.

Furthermore, the other cited references, Moynihan et al. (U.S. Patent Number 5,500,988), and Inam et al. (U.S. Patent Number 5,155,658), fail to overcome the deficiencies of the Suzuki et al., Roeder et al., and Desu et al. references.

Accordingly, Applicants submit that independent claim 1 is allowable. Furthermore, Applicants submit that claims 2-6, 8, 9, 12, and 13 are allowable by virtue of their dependency on claim 1 as well as additional recitations of novel and non-obvious subject matter.

Applicants respectfully request the reconsideration and reexamination of this application and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
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Dated: December 20, 2001

By: Robert F. Rotella Reg #24,014
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APPENDIX TO THE AMENDMENT

1. (Amended) A method of forming a thin film on a substrate in a reactor comprising a side having a shower head with a plurality of nozzles and a separate discharge nozzle, [forming] the method comprising:

[the first step of] forming a crystal nucleus of perovskite structure on the substrate, the crystal nucleus of perovskite structure comprising [of] an oxide [made up] formed of lead and titanium [on a substrate]; [and]

positioning the substrate in the reactor;

[the second step of setting] heating the substrate [having the crystal nucleus at] to a predetermined temperature[,];

supplying the reactor with [an oxide gas and] organic metal source gases [of] comprising lead, zirconium, and titanium via the plurality of nozzles, wherein the organic metal source gases are diluted with a diluent gas; [to the substrate,]

supplying the reactor with an oxide gas via the separate discharge nozzle; and

forming [on the substrate] a ferroelectric film on the substrate, the ferroelectric film comprising a [of] perovskite crystal structure [of] formed by an oxide [made up of] comprising lead, zirconium, and titanium, [at a pressure of not less than]

wherein a total pressure in the reactor is at least about 0.1 Torr.

2. (Amended) [A] The method [according to] of claim 1, wherein

[the first step comprises

setting the substrate at the predetermined temperature,

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supplying] the oxide gas and the organic metal source gases of lead and titanium are supplied to the substrate at a pressure [of] ranging from about 0.001 Torr to about 0.01 Torr[, and forming the crystal nucleus on the substrate].

3. (Amended) [A] The method [according to] of claim 1, wherein

[the first step comprises

setting the substrate at the predetermined temperature,

supplying] the oxide gas and the organic metal source gases of lead and titanium diluted with the diluent gas are supplied to the substrate at a pressure [of] ranging from about 0.001 Torr to about 0.01 Torr[,and forming the crystal nucleus on the substrate].

4. (Amended) [A] The method [according to] of claim 1, wherein

[the first step comprises

setting the substrate at the predetermined temperature,

supplying] the oxide gas and the organic metal source gases of lead and titanium diluted with the diluent gas are supplied to the substrate at a pressure of [not less than] at least about 0.1 Torr[and forming the crystal nucleus on the substrate].

5. (Amended) [A] The method [according to] of claim 1, wherein

[the first step comprises

setting the substrate at the predetermined temperature,

supplying] the oxide gas and the organic metal source gases of lead and titanium diluted with the diluent gas [made up of an evaporated gas of an organic solvent and another gas] are supplied to the substrate by dissolving at least one of [the] an organic metal [sources] source of lead and titanium in [the] an organic solvent and by

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evaporating [and supplying] the organic solvent[, and forming the crystal nucleus on the substrate].

6. (Amended) [A] The method [according to] of claim 1, [wherein

the second step comprises] further comprising: [supplying organic metal source gases of lead, zirconium, and titanium diluted with the diluent gas, to which an evaporated gas of an organic solvent is added, by]

dissolving at least one of an organic metal [sources] source of lead and titanium in [the] an organic solvent; and

evaporating and supplying the organic solvent with the organic metal source gases and the diluent gas to the reactor.

7. Please cancel without prejudice or disclaimer.

8. (Amended) [A] The method [according to] of claim 1, wherein the total pressure is at least partially achieved via the diluent gas[is irrelevant to formation of a ferroelectric film].

9. (Amended) [A] The method [according to] of claim 8, wherein

the diluent gas [is] comprises an inert gas.

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